ESTO Technology Planning

Process
Steps
Roadmaps

Presented to TST
Ames Research Center
2/6/01

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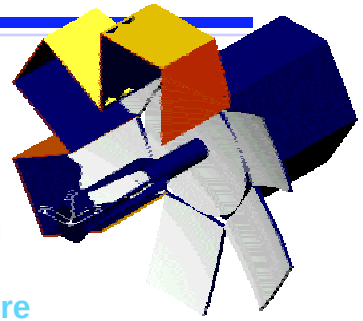
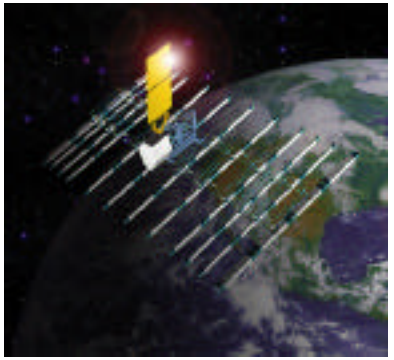
Objectives

- Provide status of roadmapping efforts
- Provide an update to ESTO and NMP integrated planning
- Propose plans and actions

Technology Priorities for Application in '05-'08



Platform	Comment
Material & Structures	**Large deployable apertures needed**
Comm	**High bandwidth downlink desirable**
GN&C	**Elements being developed elsewhere**
C&DH	**No strong needs**
Power	**No strong needs**
Instrument	
Detectors & Filters	**Nothing pressing**
Radar	**Strong needs**
Spectrometers	**No strong needs**
Optics	**No strong needs**
GPS	**No strong needs**
Lidar/ Laser	**Strong needs**
Radiometer	**Strong needs**
Info Systems	
Intelligent Platform control	**No strong needs**
On-board processing/ inst. cont.	**Strong needs**
On-board data storage/ processing	**No strong needs**
Transmission	**No strong needs**



Proposed priority technology areas

Platform	Instrument	Info systems
M&S (large deployables)	**Radar**	**On-bd. proc. / sens. cntrl**
	Radiometers	
	LIDAR / Laser	

ESTO Workshop Status

Workshop Topic	Date
Lidar/ Laser	4/20/00
Radar	4/20/00
Materials and Structures (Large deployables)	5/3/00
Information Technology	8/29/00
Radiometers	11/1/00

Information Technology Workshop

Ground Panel

Subpanels

- Large Archival Storage
- Data Discovery
- Data Exploitation
- Data Architecture

On-board Technologies Panel

Subpanels

- Space Based Computing Architectures
- Data Compression and Storage
- Intelligent Platform and Sensor Control
- High Speed Data Delivery

Information Technology Workshop
Sample Results

WBS			Suggested NASA priority (H,M,L)	Need driven by…	Need date
Category	**Functional Product**	**Task**			
Application Layer technologies	Agent Based Dynamic (network management)	Requires end to end solution and broad-team (ground and space segments) involvement. Outputs likely to impact Communication Network Architectures Category Task			
	Time synchronization	Evaluate and/or develop time synchronization time methodology and protocols for constellation spacecraft	M	Driven by Formation Flying Missions and sensor web	2002
	Intelligent Communication Agent	Develop communication methodologies for collaborative measurements and science	M	Driven by Formation Flying Missions and sensor web	2002

Why is this Important to do?	Primary technology challenge	NASA role			Comments(assumptions, possible partners, risks, flight validation needed, etc)	Projected level of Performance	Investment Plan			
		Lead	Partne	Follow			FTE (total)	Procurements	Suggested year to start	Time to TRL 6
Ensures proper tech is devel & identifies common & unique tech	Indent of parameters and issues that drive the tech	X			Functional Product is addressed in Communication Network Architectures Category	Study	2	300K	2001	-
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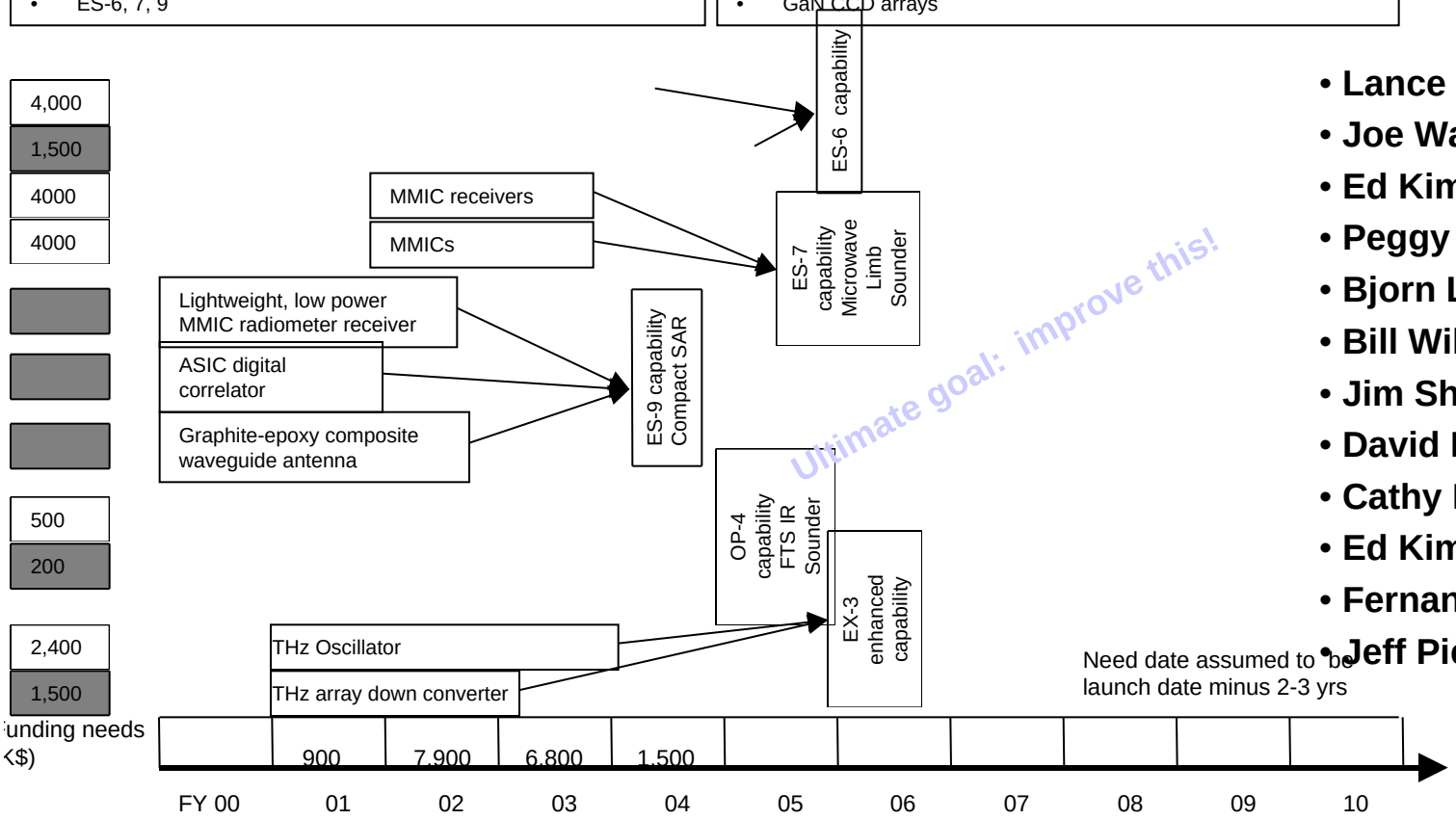
Radiometry Workshop

BMP MEASUREMENT REQUIREMENTS ADDRESSED:
- EX-3
- OP-4
- ES-6, 7, 9

MAJOR TECHNOLOGY CHALLENGES:
- Improved spectral resolution for Vis and NIR
- Minature deployable antenna for microwave
- GaN CCD arrays



Contributors
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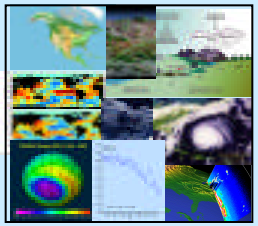
Radiometry Results

- **Needs assessed for**
  - **Active-passive systems**
  - **Polarimetry**
  - **Mm and submm systems**
  - **Mw receivers**
  - **STAR**
  - **spectrometers**

WBS			Explanation / comment	Scope		
Functional product	***Task***	***Subtask***		***Level of effort***	***No. yrs needed***	***Delivery date***
Spectrometers	Develop low power-consumption filter bank microwave spectrometers for radiometer systems	Develop low power-consumption filter bank spectrometers with bandwidth of ~2 GHz and ~25 channels having spectral resolution varying from ~100 MHz on the edge of the band to resolution of ~10 MHz at the center of the band. Goal is to achieve overall power consumption of ~20 mW or less per channel. Requirement is 80 mW or less per channel. The spectrometer must include, if needed, frequency down-conversion from radiometer IF frequencies in the ~2-20 GHz range	Needed for focal plane millimeter-wavelength array radiometer systems, where power consumption of the large number of spectrometers needed will be a limiting factor in the spatial resolution that can be achieved for certain measurements. Needed specifically for the EOS-7 MLS, and will provide significant power savings for any mission using microwave radiometry to sense the atmosphere.	2	3	2005
Spectrometers	Develop low power-consumption filter bank microwave spectrometers for radiometer systems	Develop low power-consumption spectrometers with very broad bandwidth covering ~10-50 GHz instantaneous bandwidth with ~1 GHz spectral resolution. (20 non-contiguous channels with 2 GHz spacing is acceptable.) Goal for total power consumption of the spectrometer is ~1 W or less. Spectrometer should include the 'front-end' amplifiers needed to boost input power to the level required for driving the detectors.		1	3	2005
Spectrometers	Develop programmable 'frequency-agile' microwave spectrometers for radiometer systems	Develop a generic spectrometer 'front-end' with bandwidth of ~2 GHz that can be programmably tuned over IF ranges from ~2 GHz to ~20 GHz. This will be, basically, a down-conversion module with tunable input frequency that can be inserted in a radiometer's IF system and provide a fixed-frequency output (for example, centered at ~1 GHz) that can be fed to a multichannel spectrometer 'back-end' (of any type). Goal for power consumption is ~1 W or less, although somewhat higher power consumption will still be useful.	Will (1) provide more efficient sensors for measurements that can be time-shared and (2) enable a class of 'smart' sensors that can be programmed in-orbit for targeted observations and for accommodating evolving measurement priorities. Needed for EOS-7 MLS and anticipated to be useful for other missions.	2	2	2005
Spectrometers	Develop low power ASIC autocorrelators	Develop low power ASIC autocorrelator spectrometers with bandwidth of ~2 GHz or greater and power consumption of ~0.1 mW or less per channel.	These low power ASIC autocorrelators will be designed by using very short gate lengths (<1.8 mm) and architecture to minimize power consumption by both digitizer and correlator components. Custom chips will be designed to enable programmable selection of clock speed, number of lags and bandwidth to enable a small number of chip designs to serve a broad range of radiometer applications.	3	3	2005
Spectrometers	Develop low power ASIC autocorrelators	Develop high-speed low-power digitizers for use in autocorrelator spectrometers				

ESTO / NMP Integrated Planning

Earth Science Research Plan



Baseline Measurement Studies

Earth Science Vision

Outside Technology Pipeline

Cross Enterprise Technology

Other Agencies

Industry

ESTO
Earth ScienceTechnology Office

- Instrument Incubator
- Advanced Technology Initiatives
- Advanced Information Systems Technology

Flight Validation Rationale

NMP
New Millennium Program

Future ESE Mission

ESTO / NMP Integrated Planning

ESTO Workshop Status

Topic	Date
Lidar/ Laser	4/20/00
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Materials and Structures (Large deployables)	5/3/00
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NMP Workshop Status

Topic	Date
Large, Light-Weight Deployable Antennas	4/13/00
Light-Weight Deployable UV/Visible/IR Telescopes	4/18/00
Ultra-High Data Rate Communications	4/6/00
Intelligent Distributed Spacecraft Infrastructure	5/1/00
High Performance Spectrometry/Spectroscopy	5/12/00

Joint ESTO/NMP Planning Workshop
January 23-24,2001

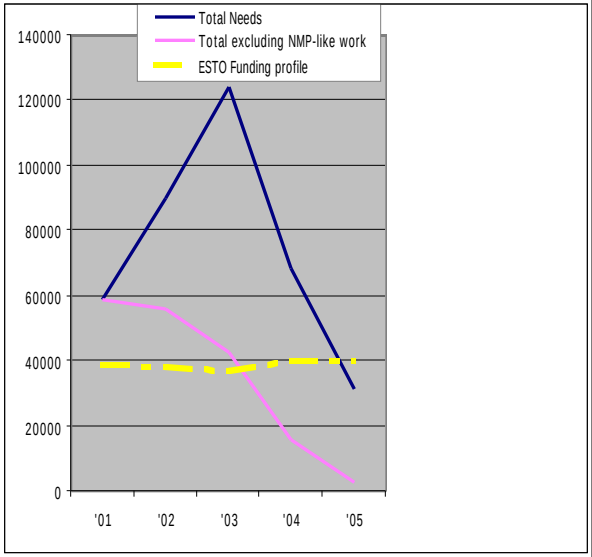
Uses/ Future Plans

- Document results for public view
  - Update Excel database of investments/ timing
  - Update technology PERT diagrams
  - Limited text to explain rationale for program
- Incorporate results into CNSAT (database)
  - Update requirements definition (quantification) with workshop results
  - Link requirements ‘properly’ (link to science mission)
- Use as basis for investment decisions
  - Match needs to delivery dates for Science experiments and missions
    - Establishment of piorities
    - Leveling of Expenditures
  - Structure NRAs to meet those needs
  - Identify unmet needs (‘holes’) so they can be addressed

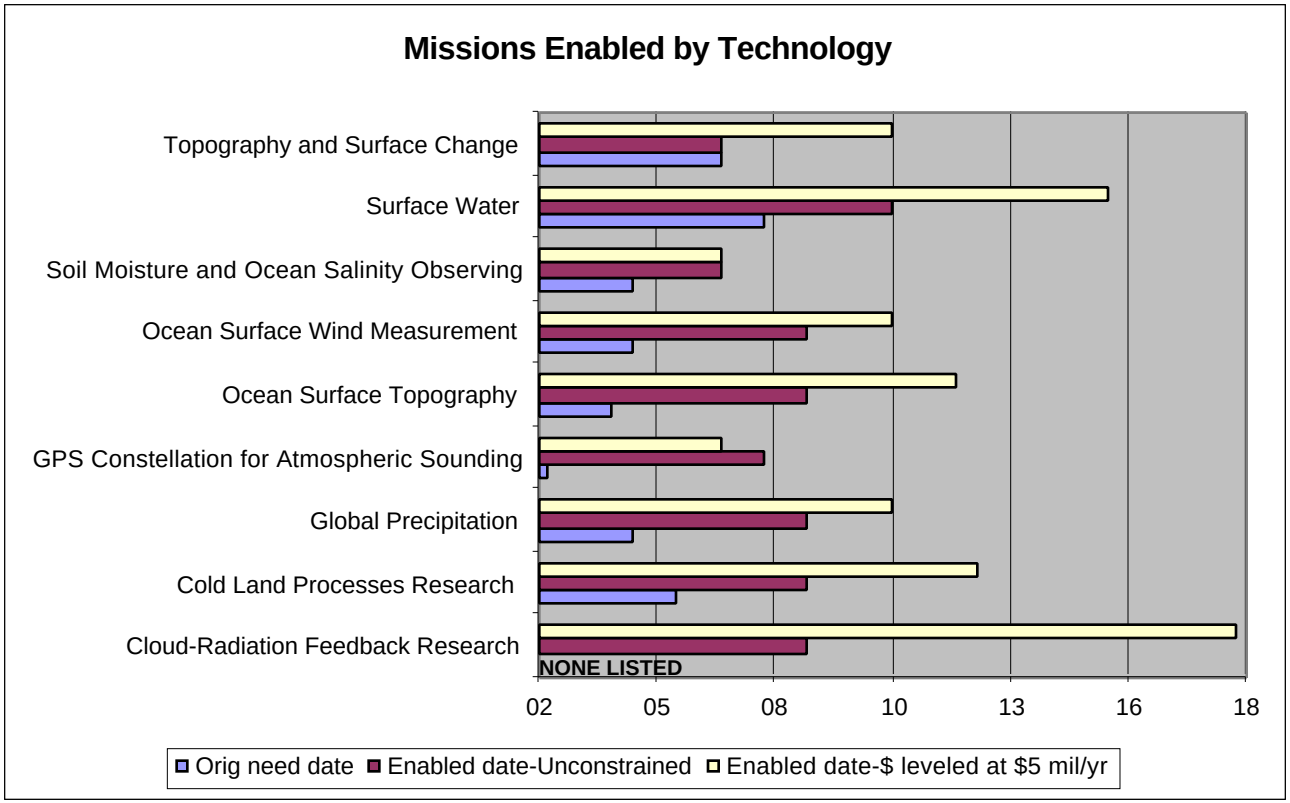
Technology Needs Correlated to Measurements

Measurement Type	COMM	Detectors/filters	GN&C	GPS	Ground Processing Systems	Intelligent Platform Control	Laser/Lidar	Materials and structures	On-board Data Processing and Intelligent Sensor Control	On-board Satellite Data Organization, Analysis and Storage	Optics	Passive radiometers, FTS	power	Radar	spectrometers	Transmission and Network Configuration
Aerosol Radiative Forcing Research		3					8				1				1	
Carbon dioxide							9									
Cloud-Radiation Feedback Research		3					8				1	3		2	1	
Cold Land Processes Research					2			1	2					5		
Global Precipitation	1		1			2			6			4		1		4
Global Terrestrial/Oceanic Productivity / Advanced Microwave Sounder	6								10			2				
GPS Constellation for Atmospheric Sounding				9								3		7		
Land Cover/Land Use Inventory	3	1	1						4	2						
Ocean Surface Topography												8		2		
Ocean Surface Wind Measurement								3						7		
Soil Moisture and Ocean Salinity Observing						3		6	10			27		4		4
Special Event Imager						1			5		3					
Stratospheric Composition Measurement	1					1	2	3	3	3		4			1	
surface water														1		
Time-Dependent Gravity Field Mapping			2				2									
Topography and Surface Change			1			1	1	3	1					2		
Total Solar Irradiance Monitoring	1					1			3	1					2	1
Tropospheric Chemistry Research							11	1								
Tropospheric Wind Sounder		2	1			1	12		5		2					
Vegetation Recovery	1		1			1	4	1	7				3			2
Volcanic Ash and Gas Emission Mapping		1				2			9		6	1			1	

Note: Numbers show the number of technology hits for a particular measurement type



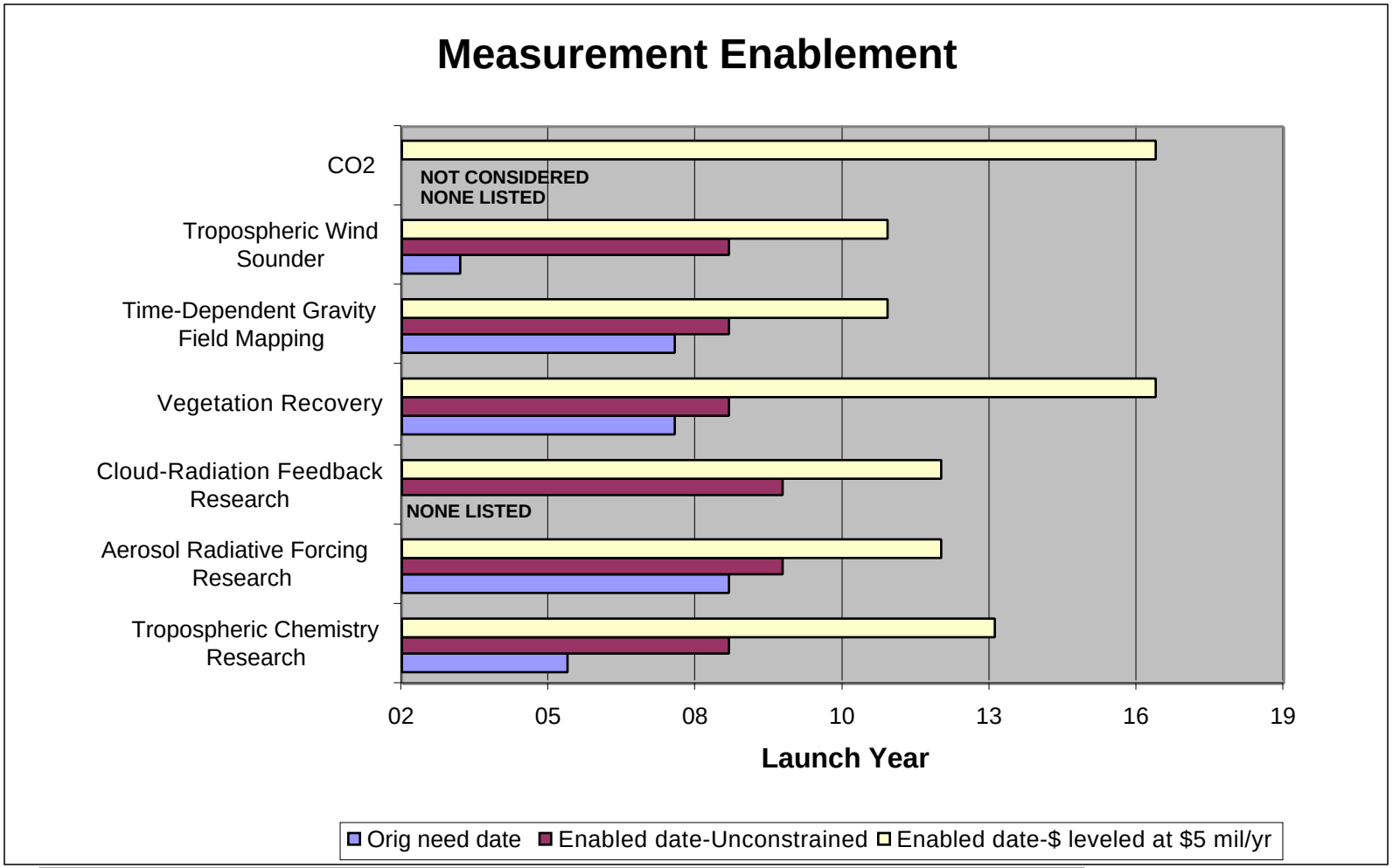
Investment plan Example: Radar



- **Observations**
  - **Cannot meet science expectations for enabling technology (even with unconstrained budget)**
  - **Budget constraints cause even further stretch-out**
  - **These observations can be generalized to all other technologies**
- **Possible Solutions**
  - **Establish highly focused measurement priorities and invest in those needed technologies**
  - **Form planning team to provide that focus**
    - **Code YS**
    - **Code YF**
    - **Code YO**
    - **NMP**

Notes:
1) ***Bars illustrate potential launch dates***
2) ***Technology assumed to be delivered 3 years prior to launch***
3) ***Technology maturity at delivery assumed to be TRL 6***

Investment plan Example: Laser/Lidar



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